FRAGMENTATION OF HIGH-SPIN STRETCHED STATES IN THE (p,n) REACTION ON ^{36}Ar AND ^{40}Ca

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High-spin "stretched-states" have been the object of many experimental and theoretical studies over the last decade. A "stretched-state" is one with a particle-hole configuration where the j's of the particle and hole are coupled to the maximum possible j-value. If both the particle and hole orbitals involve the largest j-values in their respective shells, then the state formed is the "maximum" stretched state. Because the j-value is the maximum possible involving a simple particle-hole excitation between these two shells, the state is unique within $2\hbar\omega$ of excitation. Reduction and spreading of this strength can arise from configuration mixing with more complicated configurations. These stretched states have been studied in (p,p′), (e,e′) and (p,n) reactions,[1,2] and also in transfer reactions.[3]

One of the most studied stretched configurations is the $(f_{7/2},d^{-1}_{5/2})6^-$ state observed with s-d shell nuclei targets. This 6^- state has been observed in ^{24}Mg and ^{28}Si in both inelastic proton and electron scattering.[4,5,6] The strength is observed to be predominantly concentrated in a single state; however, two problems arose concerning the 6^- strength in s-d shell nuclei. The first problem was that only about 1/3 of the simple shell-model strength was observed in the reactions on ^{24}Mg and ^{28}Si. The second problem was that this 6^- strength seemed to disappear for s-d shell nuclei heavier than ^{28}Si. Both of these problems have been addressed theoretically and experimentally.

Large-basis shell-model calculations have been performed by Carr, *et al.*,[7] which appear to describe the reduction of 6^- strength for ^{28}Si. The reduction in strength comes from mixing with the more complicated configurations, even though this reduction is much larger than one expected from such effects. The "missing" 6^- strength for heavier s-d shell nuclei is due to fragmentation of this strength in these nuclei. Earlier (p,n) experiments on ^{32}S and ^{40}Ca were able to see this fragmented strength.[8,9] This fragmentation appears as the $d_{5/2}$ hole orbital is pushed down from the Fermi surface and the $2s_{1/2}$ and $d_{3/2}$ orbitals are filled above it. The large-basis shell model calculations predict at least some of this fragmentation.

The question is now to determine just how good are such large-basis shell-model calculations. The agreement with experiment for A = 28 where there is one predominant state is very impressive. In order to test these calculations for heavier s-d shell nuclei, we performed new (p,n) measurements on the self-conjugate nuclei ^{36}Ar and ^{40}Ca.

The experiment was performed using the beam-swinger system at the IUCF in January 1993. The experiment used the "stripper loop" storage ring to achieve ~2 μs between beam bursts. This long time between beam bursts eliminated overlap background from earlier beam bursts and also greatly reduced backgrounds from cosmic rays (because the system is open for a smaller fraction of the total time). The net result was an improved signal-to-background ratio which is important in looking for the weak parts of the fragmented 6^- strength. The flight paths to the large-volume, mean-timed neutron detectors was 128 m. We obtained an overall time resolution of 750 ps, which translates into an energy resolution of 260 keV. The ^{36}Ar(p,n) data were obtained using a high pressure (6 Torr), 4 cm long gas cell with 0.5 mil Kapton windows. (Empty cell runs were used for background subtraction.)

We see clearly fragmented 6^- strength in the (p,n) reaction on ^{36}Ar and ^{40}Ca. The data are still in the preliminary stages of analysis. Comparisons will be made with large basis shell model calculations.[10]

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